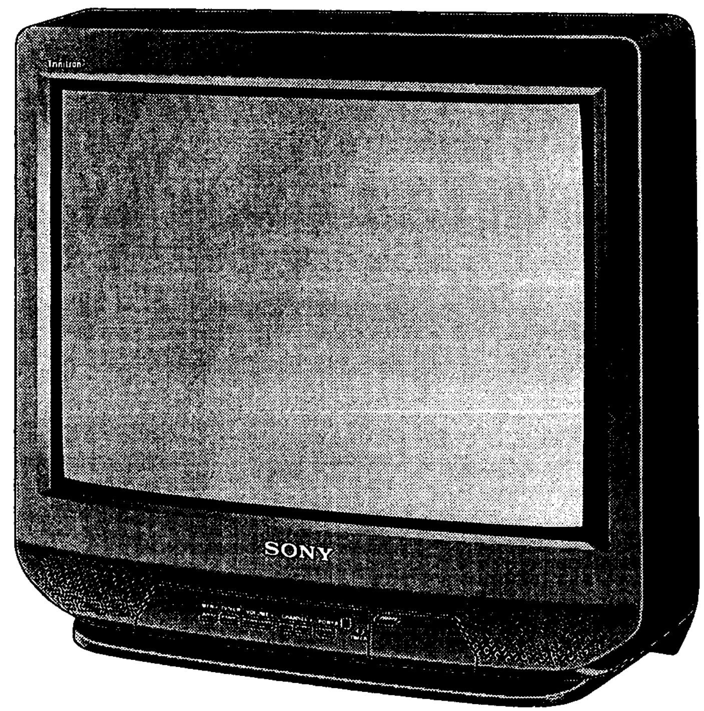
SONY®

Training Manual



Color Television

BA-4 Chassis

Circuit Description and Troubleshooting

Course: CTV-25R1

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Introduction

Sony TV Models Covered by this Manual

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Purpose

The purpose of this book is to:

- Show through diagrams and explanation how the Sony Trinitron Picture tube now works because it has evolved since inception in 1968.
- Provide organized, simplified diagrams that provide an insight to understanding the necessities of the circuit's operation. This is an essential aid to rapidly determining the cause of a failure.
- Explain the circuit operation and provide tips for troubleshooting where needed. Some parts of the circuit are used only under certain conditions of operation. It is important to know when these additional parts affect the main circuit during operation and how they affect the main circuits if they are defective.
- Provide some voltages from a working production run set that are not supplied in the service manual. These can be compared to the non-working unit you are repairing to determine where the fault is.
- Explain the new self diagnostic circuit:

1. How to access it
2. How it works,
3. When to use it
4. The circuits that support it

Note:
This note is common to all schematics and block diagrams.
All capacitors are *uf* unless otherwise noted.
All resistors are *ohms* unless otherwise noted.
All voltages are *dc* unless otherwise noted.

The Trinitron® Picture Tube

The Cathode Ray Tube (CRT) has been slowly changing since its conception about 50 years ago. Since then the emitter, accelerator and focus structures at the "gun" end have been added to the vacuum tube to shape and control the amount of electrons from the gun.

At the target end of the CRT, the luminescent screen is made of a phosphor mixture. Phosphor glows white when struck by electrons. Phosphor brightness is directly proportional to the amount of electrons that strike the phosphor. The CRT sport brightness was controllable with a gun and phosphor screen.

The electron beam produced a spot of light that was stationary on the phosphor screen. Placing an electromagnetic field near the electron beam after it left the gun created movement. The spot intensity and location were now controllable and the CRT became known as the picture tube.

To produce a color picture on the CRT screen; three independent gun structures are used. The electron guns produce different amounts of electrons targeted to their corresponding Red, Green and Blue phosphors. Red, Green and Blue are the primary colors for light.

In 1968 the Sony Trinitron picture tube was a departure from the traditional three-gun color picture tube. Three major changes to the old color tube created a distinctive Trinitron picture tube:

1. Instead of three small electron guns, focus was improved using one large electron gun structure that all three beams pass through.
2. Electrostatic convergence plates were added to bend the outer electron beams so they would land on the corresponding red and blue color phosphor.
3. A continuous vertical slotted aperture grill at the screen end that:

- Reduces the effects of terrestrial magnetism.
- Prevents adjacent and stray electrons from striking the wrong phosphor.
- Allows more electrons to pass, increasing brightness without shortening life.
- Results in a flat screen. This reduces annoying room light reflections (glare).

The remainder of this document is divided into four sections explaining the construction of Trinitron tube as an aid to the service technician:

- The Trinitron Electron Gun Operation
- The Trinitron Screen
- Picture Tube Defect Symptoms
- Picture Tube Handling and Vacuum Disposal

The Trinitron Electron Gun Operation

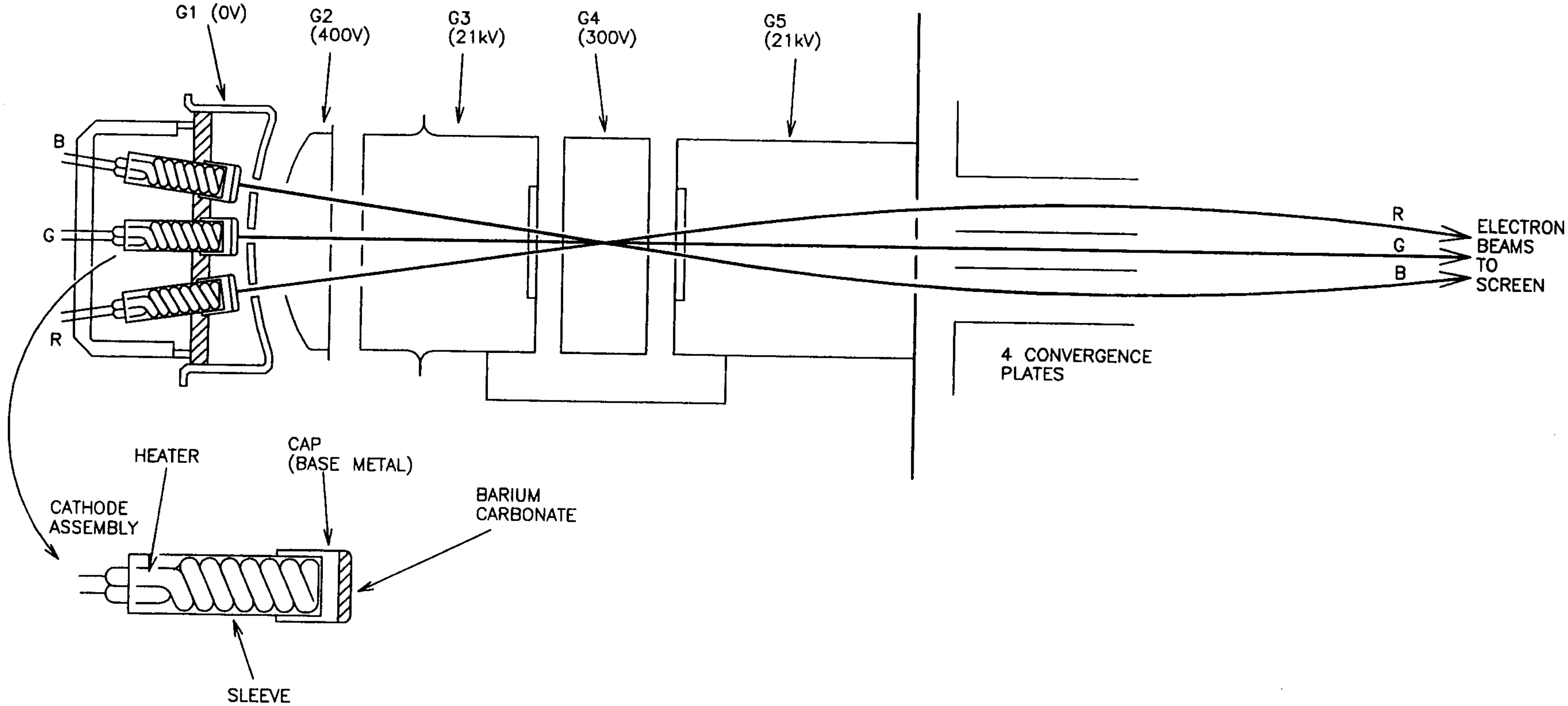
The Sony Trinitron electron gun consists of three cathode assemblies, five grid structures and convergence plates:

Three cathode assemblies

When heated, electrons are given off from a Barium Carbonate ($BaCO_3$) surface deposited onto a cap. The cap serves as a holder for the $BaCO_3$, white mixture. The cap is fastened to a sleeve that houses a heating element (filament). This assembly is called a cathode.

There are three cathodes in the beginning part of the gun assembly by the pins of the CRT. They all supply electrons in controlled amounts. The center cathode on the Trinitron tube produces the amount of electrons that correspond to the green color information. These electrons will eventually land on the green phosphor if things go well on the journey. The outer cathodes are angled slightly to send electrons through the gun structure. Their final targets are the red and blue phosphor at the screen.

Next a voltage is connected to the cathode (sleeve) and a more positive voltage to the second grid (two) in the gun structure. This difference in potential will pull the electrons from the cathode's Barium Carbonate ($BaCO_3$) surface into the gun structure. The difference in potential voltage between the cathode and grid two will determine the amount of electrons emitted. More electrons landing on the phosphor (screen) will increase the color spot intensity.



TRINITRON ELECTRON GUN

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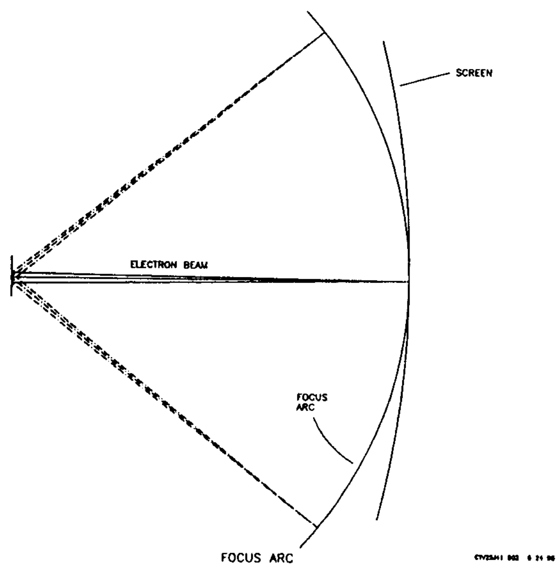
Grid ring five is applied a very high voltage to accelerate the beam so it comes to a fine point some distance away (at the center of the screen). The ratio of voltages at G4 and G5 determines where the focus point is positioned. This focus point forms an arc when the electron beam is swept from left to right by the deflection yoke.



Unfortunately, the picture tube screen does not match this focus arc, so the beam will only be in focus at the center of the screen. To correct this physics problem, the G4 focus grid voltage is modulated with a parabolic waveform (shape is like a bowl) at the horizontal rate. The parabolic waveform moves the focus points forward so they match the screen.

In a TV, high voltage drops during bright scenes because of heavy *current demands. When the high* voltage applied to grid five drops, the G4-G5 focus voltage *ratio* changes. This voltage change causes the focus point to change during the brightest spots. One method to maintain the focus voltage ratio is to take both the focus voltage for G4 and high voltage for G5 from the same flyback secondary transformer winding. If G5's high voltage drops, so does the G4 focus voltage. The focus voltage ratio and picture focus are maintained during bright scene changes.

The focus is customarily adjusted for sharpness when snow (no station) is present. The rapid changes from black to white when snow is displayed on the screen are the most taxing on the high voltage system. Setting the focus under these dynamic conditions will insure a well focused picture within the normal viewing range.

Convergence Plates

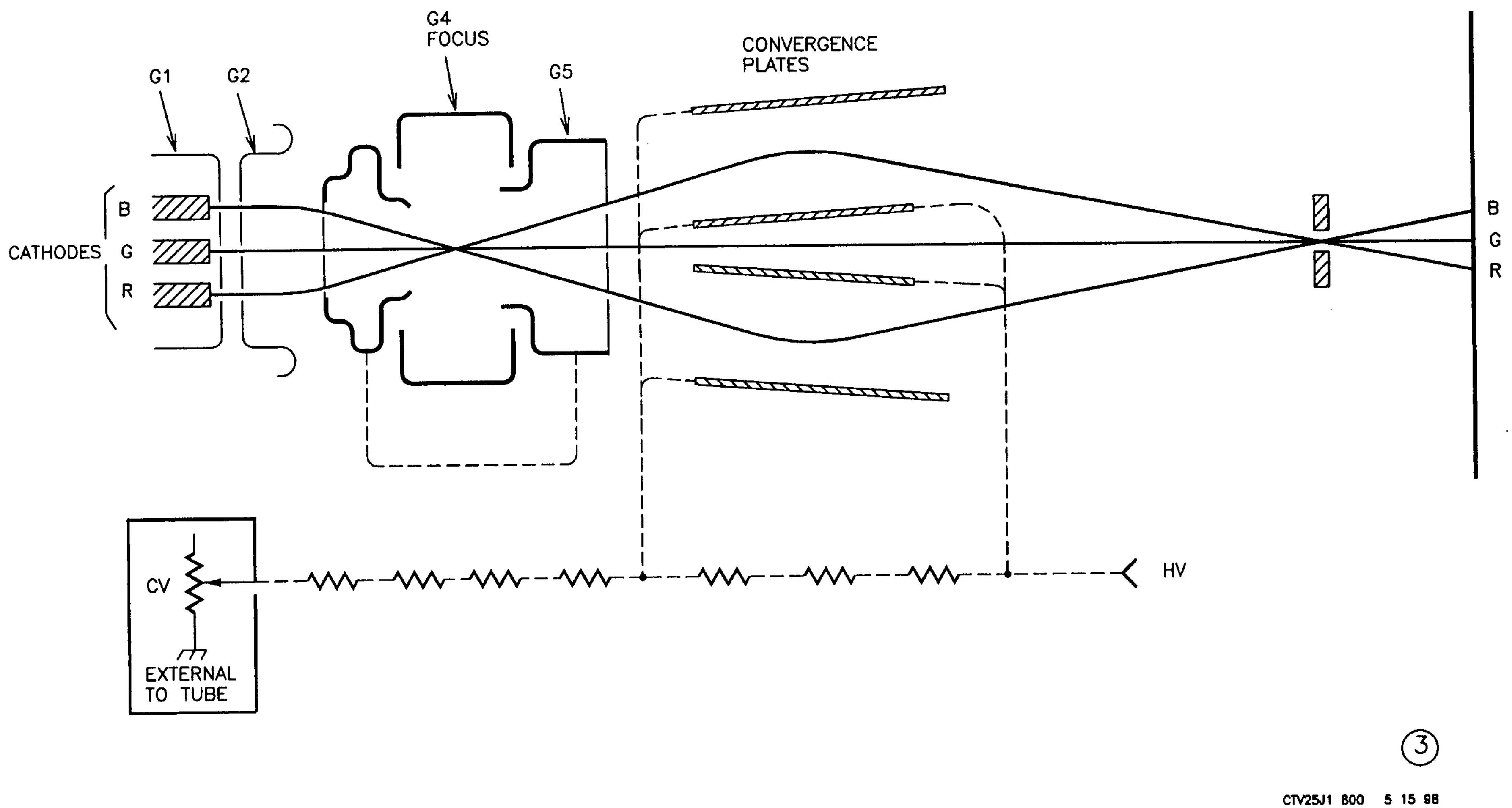
The Trinitron gun uses one gun, which three electron beams pass through. These three beams diverge as they pass out of the gun. Electrostatic convergence plates bend the outer electron beams back so they land adjacent to the center electron beam on the corresponding red and blue phosphors.

Four convergence plates are used to bend the outer electron beams. The two center plates are connected to the flyback generated high voltage. The two outer plates are connected to a voltage a few hundred volts less than the high voltage. A variable resistor (CV) external to the picture tube determines the exact voltage.

As the outer two electron beams pass through the convergence plates, they are bent (attracted) inward toward the higher voltage plate. Adjusting the CV control changes the voltage to the outer convergence plates. The deflection angle of the outer beams can be changed so they converge and pass through the same aperture grill slot by the screen as the center green beam. After the beams pass the aperture grill, they diverge to land on their corresponding red, green and blue phosphors to produce a white dot.

An incorrect adjustment of this CV control causes the outer beams to pass through other slots in the aperture grill. The outer beams will produce a red and blue dot near the green one instead of a single white dot.

There is no CV control in newer Sony TV sets. The CV control end of the picture tube's high voltage resistor is grounded so there is still a difference in convergence plate potiential. Plastic rings with tabs called "V-Stat" control permit you to magnetically perform the same static convergence as the CV control. These plastic rings are located at the back of the yoke and contain a few small pieces of metal molded into the plastic. This metal alters the yoke's magnetic field for beam convergance.



CONVERGENCE PLATES

The Trinitron Screen

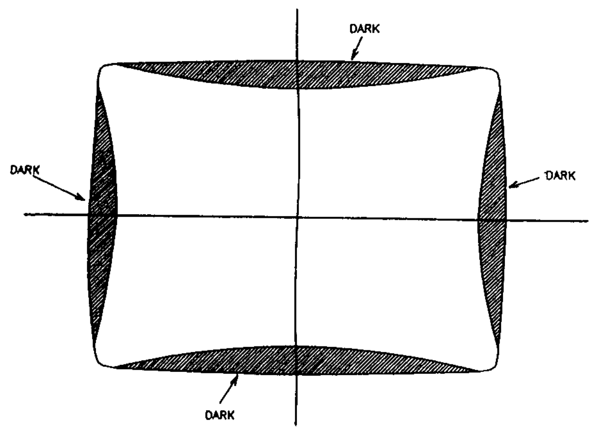
In front of the electron gun are the:

- Deflection Yoke
- Aperture Grill (AG)
- Phosphor Stripes
- Getter Assembly

Deflection Yoke

The yoke consists of two coils of wire mounted on the glass bell of the picture tube in front of the (internal) convergence plates. One coil generates a magnetic field to move the electron beams in the X-axis and the other coil moves the beams in the Y-axis. Guided by the deflection yoke, three electron beams first sweep across the aperture grill along the X-axis from left to right (from the front as you would watch TV). At the end of the horizontal sweep, the beam retraces back to the left side of the screen. Meanwhile the yoke's magnetic field moves the three beams down (Y-axis) one line before the beams sweep horizontally across the aperture grill again. This process then repeats. Finally, at the bottom right corner of the picture, the beams are returned to the top left corner of the screen.

The deflection yoke has difficulty providing a magnetic field to sweep the beam so it matches the screen shape. The yoke's magnetic field is stronger at the corners of the picture then at the top/bottom and sides (X & Y-axis).



Improvements in deflection yoke construction have compensated for the reduced top/bottom deflection (Y-axis). Along the X-axis, the weaker magnetic field causes the picture to look like an hourglass. This is because there is insufficient picture scan, which produces a dark area at the left and right sides of the picture tube.

Increasing the current through the horizontal windings of the yoke compensates for this hourglass picture. The yoke current is then gradually increased line by line until the middle of the picture for maximum width , the curve is reduced as the beam continues to scan downward. The result is a straight picture. This type of yoke distortion to the picture is called pincushion distortion. The correction circuit that changes the yoke current is called the pincushion stage.

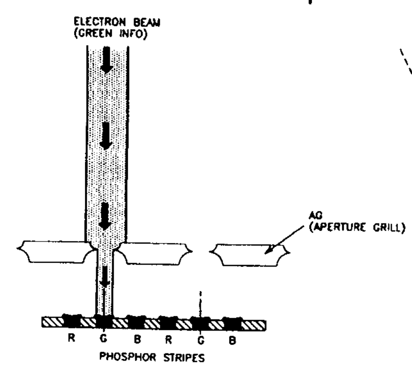
Aperture Grill Construction

The aperture grill (AG) is an aluminum panel located behind the picture tube screen with vertical slits cut out. The aperture grill is welded to a steel frame that holds it completely flat in the vertical direction and curved in the horizontal direction. Consequently, the resultant picture tube face shape is like the front of a cylinder. This flatter surface reflects less room light and, therefore, produces fewer glares from the ambient light. This is another feature that sets the Trinitron apart from other picture tubes that are spherical in shape.

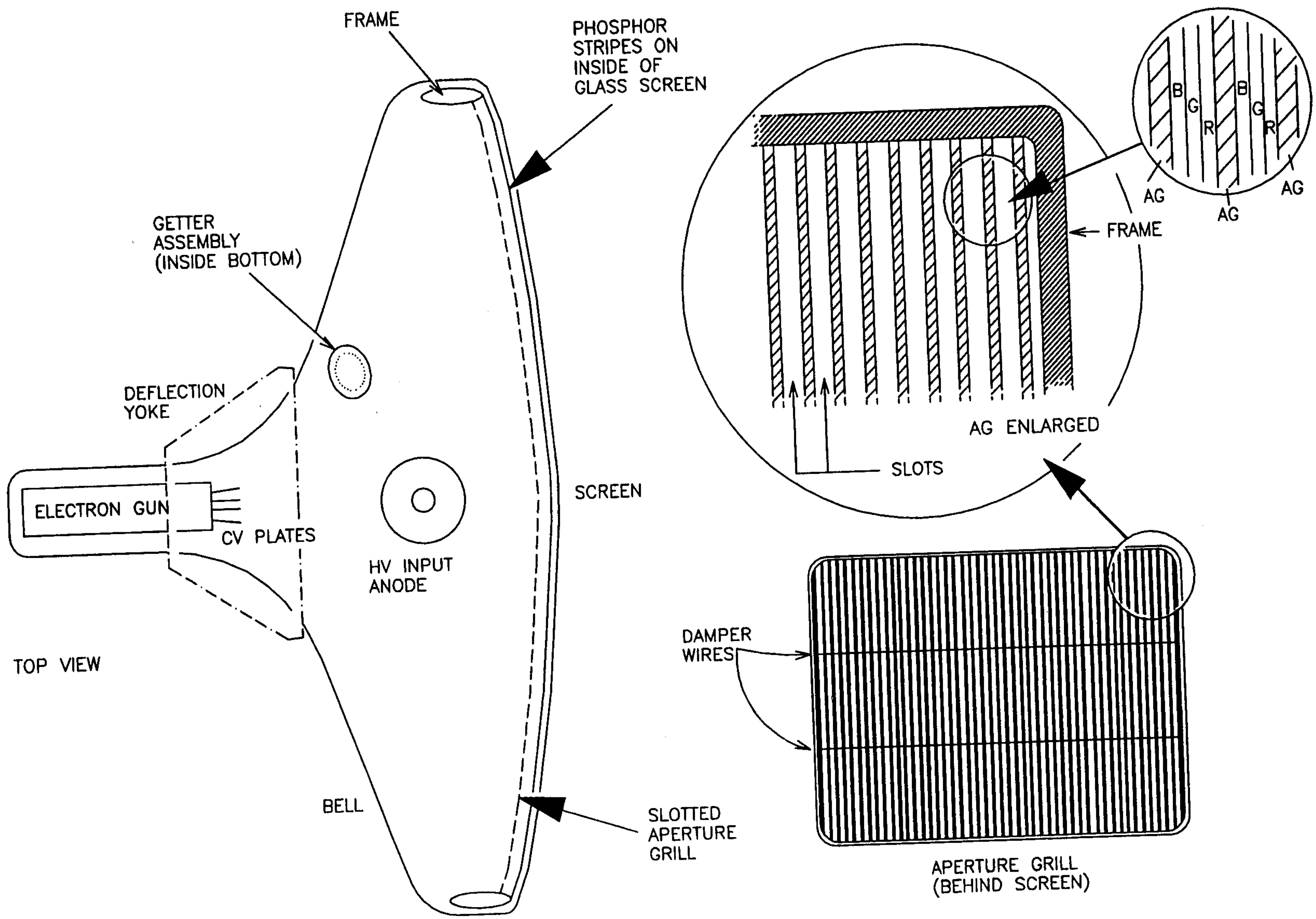
Although the grill is held flat, it still can move slightly, especially in larger tubes. In larger tubes, there are two horizontal wires that run across equidistant across the grill, preventing the slots from vibrating or shifting. These two wires found in the grill are called anti-vibration damper wires.

Aperture Grill Purpose

In diagram 5, the slits in the aperture grill allow the electron beam to pass through and land on the phosphor. The electron beam meant to land on the green phosphor is shown:



ELECTRON BEAM LANDING (GREEN)



TRINITRON PICTURE TUBE

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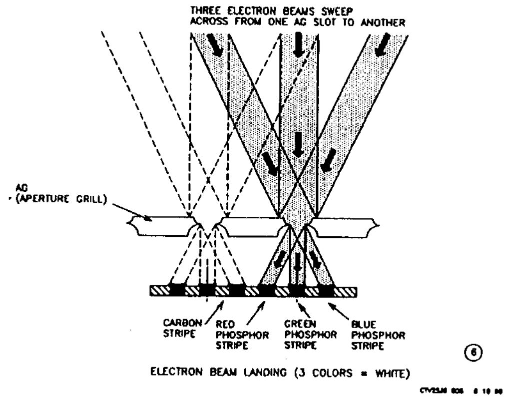
In diagram 6 you can see the slits have a more important purpose. When all three beams are turned ON, the narrow AG slots prevent adjacent electron beams from landing on the wrong color phosphor. The aperture grill slots only allow electron beams to pass through and land on their corresponding color phosphor.



Phosphor Stripes

Phosphor is a powder that becomes luminescent when bombarded by electrons. The color and persistence of phosphor glow after electron bombardment is determined by using additional chemicals combined with the phosphor. Three different color phosphors are painted in vertical strips that correspond to aperture grill slits. The phosphor strips are separated by carbon stripes that do not glow when struck by electrons. These carbon stripes allow for manufacturing tolerances when making the AG and painting the phosphor stripes.

Getter Assembly

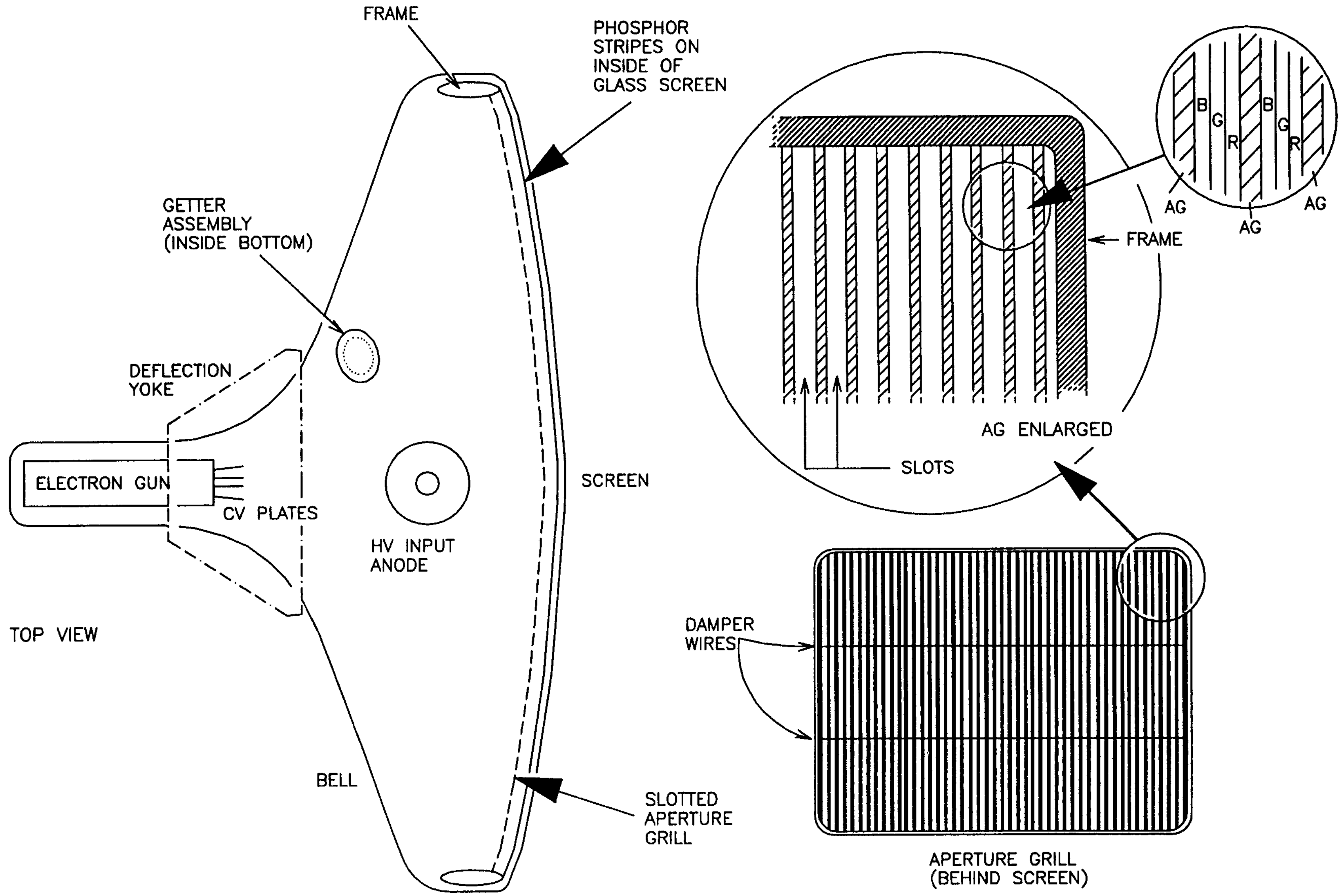
Electron emission efficiency and cathode life are greatly dependent upon a clean environment inside the CRT. After the air is pumped out of the CRT and sealed, residual water vapor, carbon dioxide and oxygen inevitably remain.

A small cup attached to the gun assembly containing a barium compound is placed inside the picture tube. After sealing the glass picture tube, the Getter is "flashed" with a high level of RF energy. The barium compound heats up and evaporates, combining with the residual undesirable elements in the picture. The resultant compounds that are created coat the inside walls of the picture tube without consequence. The result is a longer tube life because of the cleaner environment.

Picture Tube Defect Symptoms

Several problems can occur in new picture tubes. The bench technician can solve some problems and avoid a picture tube replacement.

Defective Picture Tube Symptoms			
Symptom	Suspect	Check	Procedure
Dark picture or one color missing.	Heaters Open	Apply 6Vdc to the heater terminals. Some heaters are connected in parallel, others in series but all take 6Vdc.	Clean the CRT pins and examine the socket for corrosion. Apply 6Vdc to the CRT heater pins, looking for a glow in all 3 heaters. Then if a heater(s) does not glow, replace the picture tube.
Dark picture	Grid 1 to Grid 2 short.	There should be infinite resistance between the G1 and G2 pins.	1. Unplug TV and remove video board. 2. Apply 15-20Vdc between the G1 and G2 pins to vaporize the short. Current limit the power supply to 1 Amp.
Bright red, green or blue picture One color retrace lines may be present. Retrace lines are diagonal lines that run from lower left to the upper right corner.	Heater – Cathode short. OR Cathode to Grid 1 short.	Remove the R, G or B video output transistor of that bright color. If that color is still bright, the tube is bad. There should be infinite resistance between any CRT pin to either Heater pin. *	1. Unplug TV & remove the video board. 2. Apply 15-20Vdc between the pins that show resistance to vaporize the short. * Current limit the external power supply to 1 Amp.



TRINITRON PICTURE TUBE

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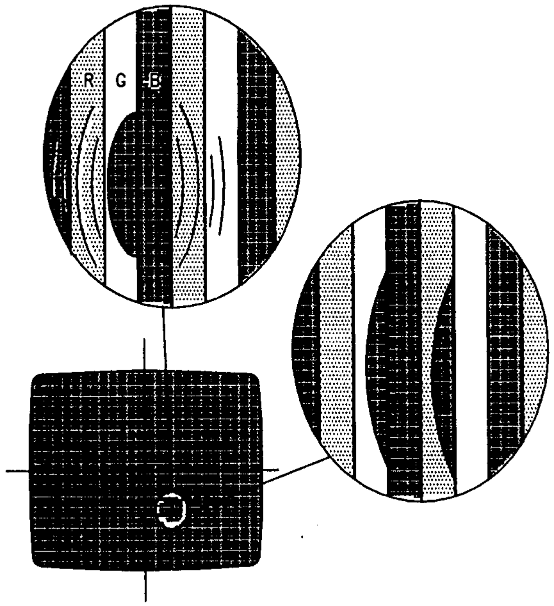
Defective Picture Tube Symptoms

Symptom	Suspect	Check	Procedure
Bright picture with retrace lines and/or poor focus.	Grid 2 to high voltage Grid 3 leakage.	Symptom is that <u>all</u> three colors are bright.	Reduce G2 / screen voltage to the lowest setting. Vary focus control to both limits several times. Put on safety apparel. Place the tube face down and lightly tap the neck to dislodge the particle.
Black spot on the screen. (see black spot diagram)	Dust lodged in the aperture grill.	Generate a white raster. Inspect grill with magnifying glass.	Mark location and pull TV. Follow safety instructions. Apply light impact with rubber mallet (see diagram).
RGB Rainbow. (see rainbow picture)	Aperture grill was unseated in transit.	Rainbow of colors can start at the top or bottom (bottom rainbow shown).	A loose aperture grill is dangerous and may cause tube implosion. Use all safety precautions. Do not jar set. Transport face down,.
Purity / Beam landing is off.	The TV's degaussing circuit did not demagnetize aperture grill metal support.	Same color blotches remain at that area of the screen regardless of picture screen changes.	**Do not manually Degauss the picture tube with your strong degaussing coil **.** Repair the TV's degaussing circuit. The thermistor is usually at fault.

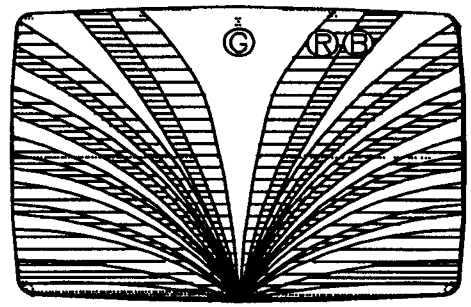
* Only the heater pins should have resistance. All other pins have infinite (∞) resistance to each other and to either heater pins.

Highly-used picture tubes that have a heater-cathode leakage/short have a low restoration success level.

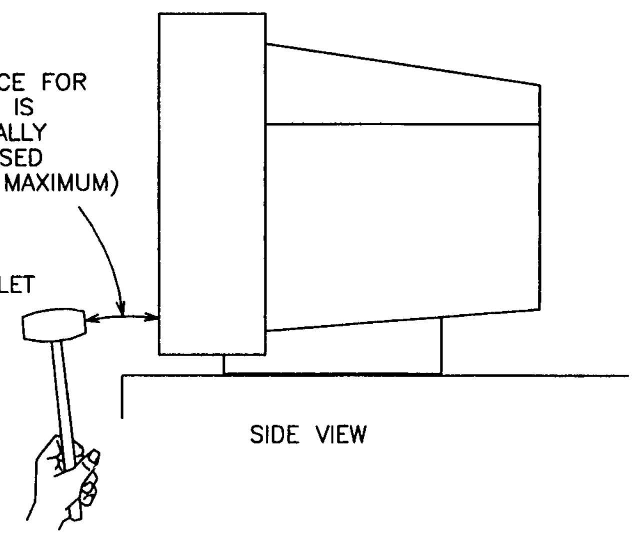
** Do not manually Degauss. New 27' – 35" picture tubes are magnetically "conditioned" for optimum beam landing. Strong manua degaussing will destroy this conditioning. Applying disc magnets (P/I = 1-452-094-00) to the bell of the picture tube is the only way to compensate for lost magnetic conditioning. The Sony manual degaussing tool can be used to degauss these tubes because of the reduced field intensity (P/N = 7-700-781-01).



BLACK DUST SPOT ON THE PICTURE TUBE'S APERTURE GRILL



RGB RAINBOW (UNREPAIRABLE)



DISLODGE THE DUST PARTICLES WITH A RUBBER MALLET

Picture Tube Handling and Vacuum Disposal

Once you have determined that the CRT is inoperative, air should be let into the tube. This will reduce the risk of implosion caused by a sudden loss of vacuum.

There are two good methods of "airing" the tube:

A. Puncture through the anode button.
B. Break the thin glass seal at the neck.

The first method allows air to enter the tube gradually.

A. Puncture through the anode button.

Air can be let in gradually by making a hole inside the high voltage anode. The anode is located at the stronger bell part of the picture tube. ***Read the procedure below first:***

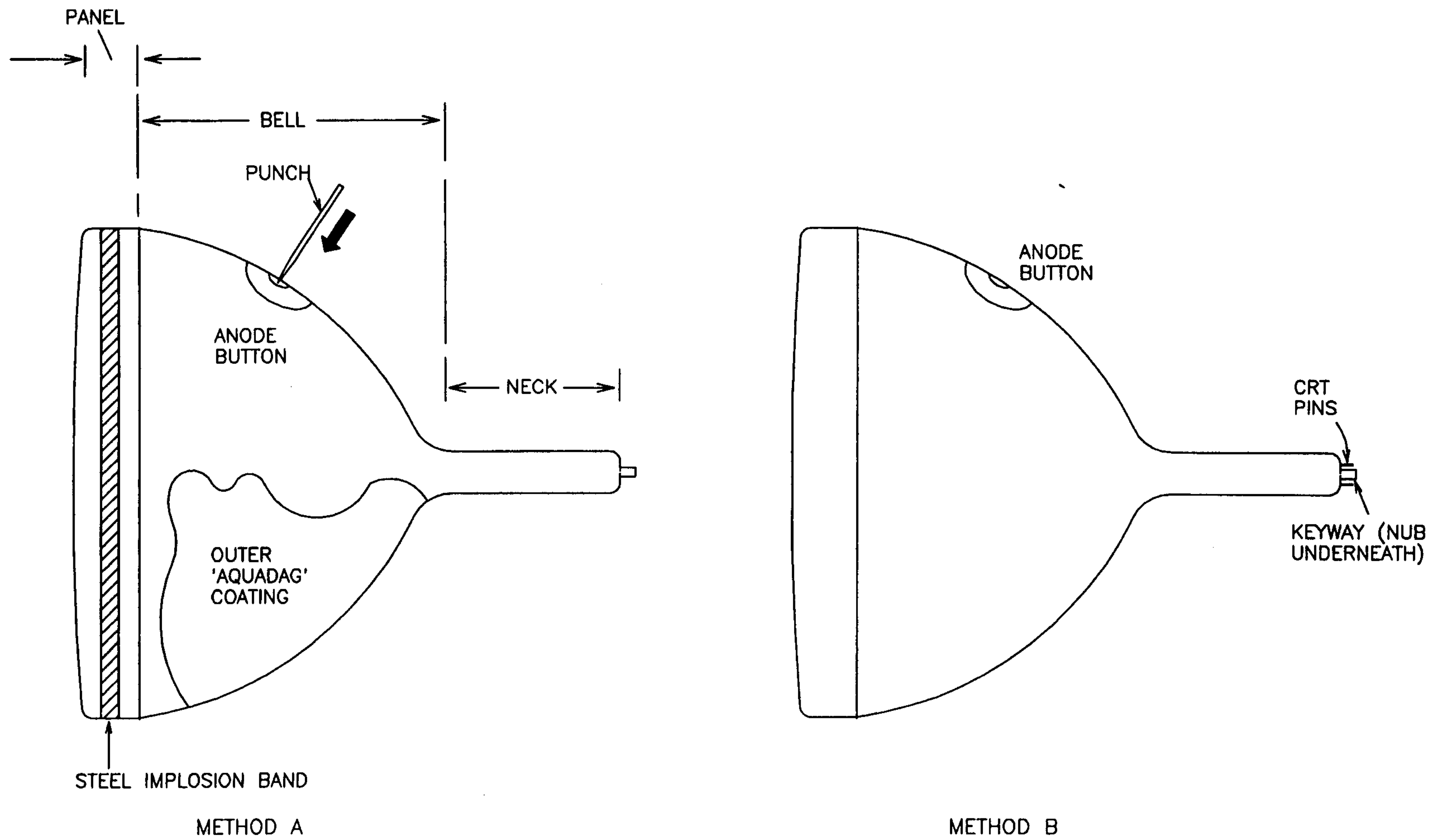
1. Put on protective goggles, gloves, apron and shoes as specified in the picture tube safety precautions.
2. Check that there is still a steel implosion protection band about the panel of the 27" or larger picture tubes. See the picture for the location. If it is not present, do not air the tube. Call for professional disposal.
3. Next, the high voltage stored by the picture tube must be discharged. The picture tube capacitor has two plates. One plate is inside, connected to the HV anode button. The other plate is outside, connected to ground. The tube's outside conductive plate is a black graphite "aquadag" coating. Use a high voltage probe (self contained)to gradually discharge the high voltage (HV) with the TV off.
4. Clip one end of a jumper wire to the chassis strap resting on the conductive black aquadag coating of the picture tube bell. Connect the other end of the jumper wire to the anode terminal. Leave the jumper there for about a minute to make sure the picture tube capacitor is completely discharged. During this time, inspect the bottom area of the picture tube to make sure the ground strap is touching the black aquadag coating.
5. Using a small screwdriver or center punch as a puncturing tool, seat it into the center of the soft lead anode button cavity (hole). The puncturing tool must be able to pass through the anode hole and not touch the anode button's outer metal rim.
6. Being careful not to hit the glass with the hammer, gently tap the tool further into the anode button. The anode is made of a soft lead amalgam that will give inward.
7. The hissing sound when the punch is wiggled out means that the tube is "aired".

B. Break the thin glass seal at the neck.

Method B for releasing the picture tube vacuum is to break the glass nub at the neck of the tube. ***Read the procedure below first:***

1. Put on protective goggles, gloves, apron and shoes as specified in the picture tube safety precautions.
2. Check that there is still a metal implosion protection band about the panel of the 27" or larger picture tubes. If the band has been removed, do not proceed with this vacuum disposal procedure.
3. There is a plastic keyway at the pins of the CRT. Remove the plastic keyway by wiggling it off. This exposes the glass nub that was sealed to maintain the vacuum.
4. With a pair of long nose pliers or diagonal cutters, break this glass nub by squeezing it to shatter the glass. The tube is "aired".

Picture Tube Safety Precautions
• Wear safety goggles even over glasses to prevent side glass entry
• Handle the picture tube with the correct size work gloves for your hands to avoid slipping
• Change to a thick long sleeve shirt to avoid exposing your skin to glass fragments
• Wear a thick rubber apron
• Wear shoes to protect your feet
• Find a partner to help move or reposition the picture tube. Your partner needs protective gear more than you do



CRT VACUUM DISPOSAL

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Overall Block Diagram

A TV set consists of several stages or blocks:

- Power Supply
- Power On/Communications
- Video Processing
- Deflection

Each stage has a purpose and is activated in sequence to properly power up the set.

Power Supply

The purpose of the power supply is to convert the incoming 120Volts AC to some of the DC voltages required to operate the set, the most important of which is the Standby +5Vdc. Standby +5Vdc is present when the set is plugged in and is used to power the Micro so it can respond to a TV power ON command from the user.

Power On/Communications

Three things occur when the power button is pressed:

1 Degaussing of the picture tube

2 Application of power to the Y/C Jungle IC

3 Data communications

When the TV is powered ON, the Micro turns ON the degaussing circuit for 2.2 seconds. Its purpose is to pass AC through the degaussing coil that surrounds the picture tube. The AC field that is created erases residual magnetism collected by the tube's metal aperture grill.

Next the Micro IC turns the TV ON switching power from the power supply to the Y/C Jungle IC. The Y/C Jungle IC produces vertical (VD) and horizontal (HD) pulses to create the remainder of the voltages necessary for the TV to operate. This turns ON the TV (see **Deflection**).

After the TV turns ON, data and clock communications from the Micro IC are applied to the tuner and Y/C Jungle IC. The tuner is instructed to tune to the last station viewed and the Y/C Jungle IC is instructed to select the last video input used before the set was turned OFF.

The communications data and clock lines are always active when the TV is ON.

Video Processing

The Y/C Jungle IC selects a video signal from one of two external video inputs or the internal tuner video for processing. Contrast, brightness, color level and hue are also controlled in this IC. A change in level is received by the Micro IC, stored in memory, and communicated to this Y/C Jungle IC thorough the data and clock inputs. The final stage within this IC converts the information to individual red, green and blue (RGB) output voltages. The higher the voltage, the greater the intensity of that color. The three RGB voltages are applied to the video output stage.

The purpose of the video output stage is twofold:

1. To invert the signal
2. To convert the small red, green and blue input voltages to larger voltages for the picture tube drive

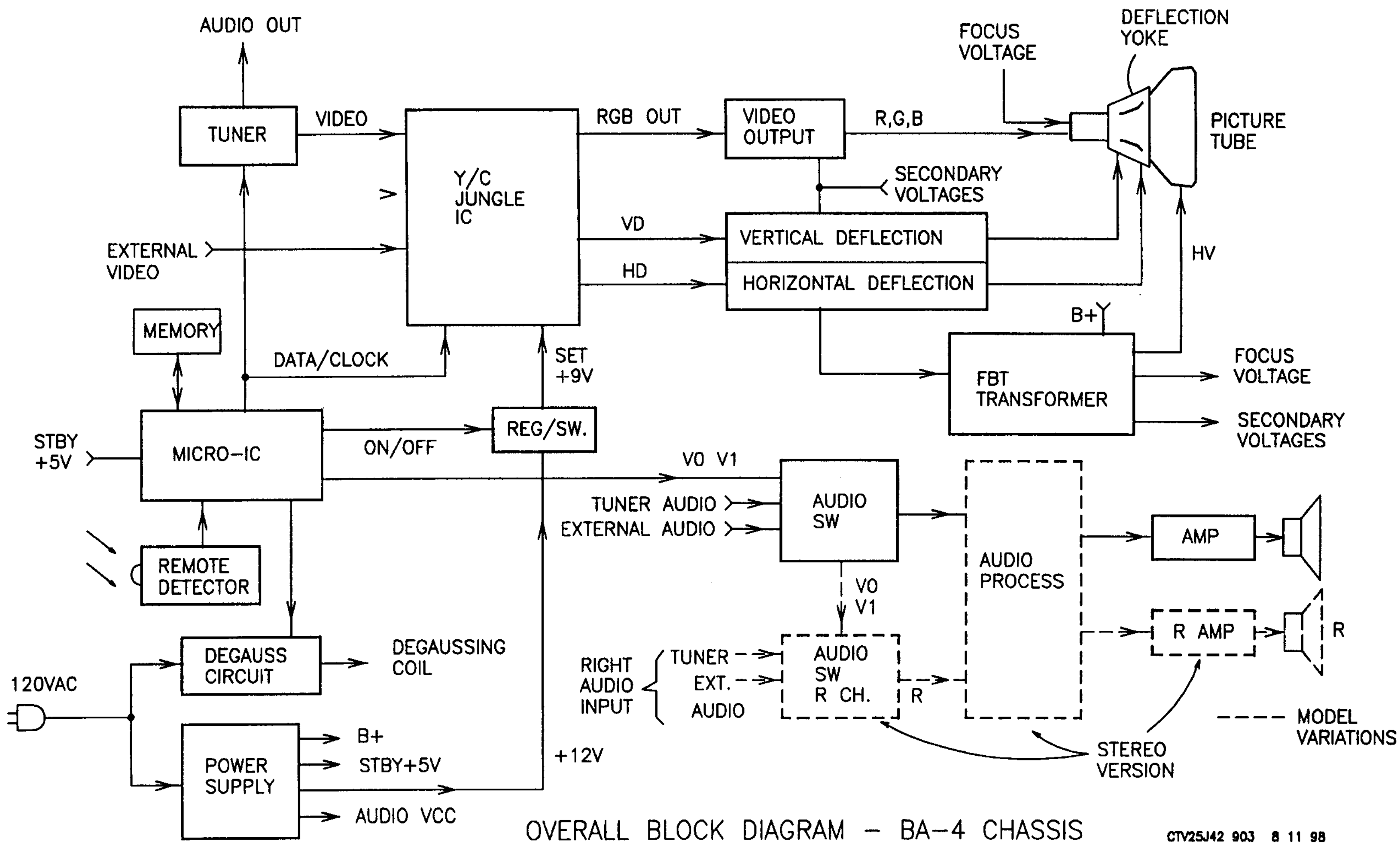
The voltage output of this video stage is applied to the picture tube cathodes. This voltage varies from 200 volts for a dark picture to zero volts for a very bright picture.

Deflection

When the Y/C Jungle IC receives power and serial data, its internal vertical and horizontal oscillators operate and output. These two VD and HD signals leave the IC to drive the external deflection amplifiers. The output of the vertical deflection stage drives the vertical deflection coil of the yoke. The purpose of the vertical yoke coil is to move or "sweep" the picture tube's electron beam downward to produce the picture.

The yoke and flyback transformer (FBT) use the output of the horizontal deflection stage. The yoke uses this drive signal in the horizontal deflection coil to sweep the electron beam from left to right and back (retrace) to produce the picture.

The flyback transformer is a low current high frequency transformer that develops the remainder of the voltages the TV set needs to operate.



OVERALL BLOCK DIAGRAM – BA–4 CHASSIS

Power Supply Block – 20” TV & smaller

In the smaller BA-4 chassis TVs, power is applied to most of the TV stages when the set is plugged into 120Volts AC. Three stages develop and regulate the four voltages that leave the power supply:

1. The converter stage
2. The voltage output stage
3. The power output control

The Converter Stage

The purpose of the converter stage is to change the low frequency (60Hz) AC that is input to this stage into a high frequency AC signal that will output this stage. To do this, several operations take place within the converter stage:

- The 120Volts AC input is rectified into DC and filtered.
- This DC voltage powers a medium power, high frequency oscillator. An oscillator is used in this converter stage because its frequency is easily controllable and the high frequency output can pass through a small lightweight transformer. This keeps the entire TV lightweight and efficient.
- The high frequency AC output of the oscillator is applied to the next stage for multiple voltage outputs.

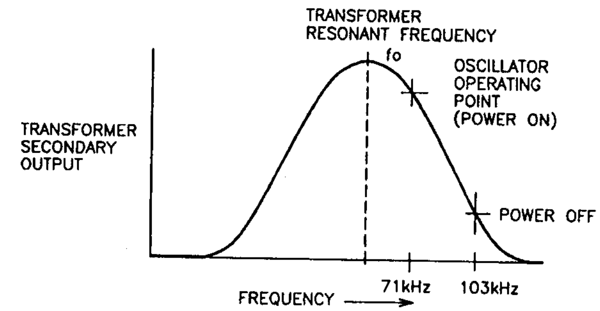
The voltage output stage

The purpose of this voltage stage is to provide multiple voltages to the TV. The oscillator signal from the converter stage is applied to a transformer in the voltage output stage. The transformer's secondary windings are used to make the four voltages. The most important voltages are the standby +5V and the B+ voltage. In the 13” and 20” BA-4 chassis, the B+ is +116Vdc. In the 27” TV, B+ equals +135Vdc.

- The standby +5V is used to power the microcomputer.
- The (B+) is used to power the horizontal deflection and high voltage stages. Variations in the B+ voltage will cause the picture to change in width and brightness.

The power output control.

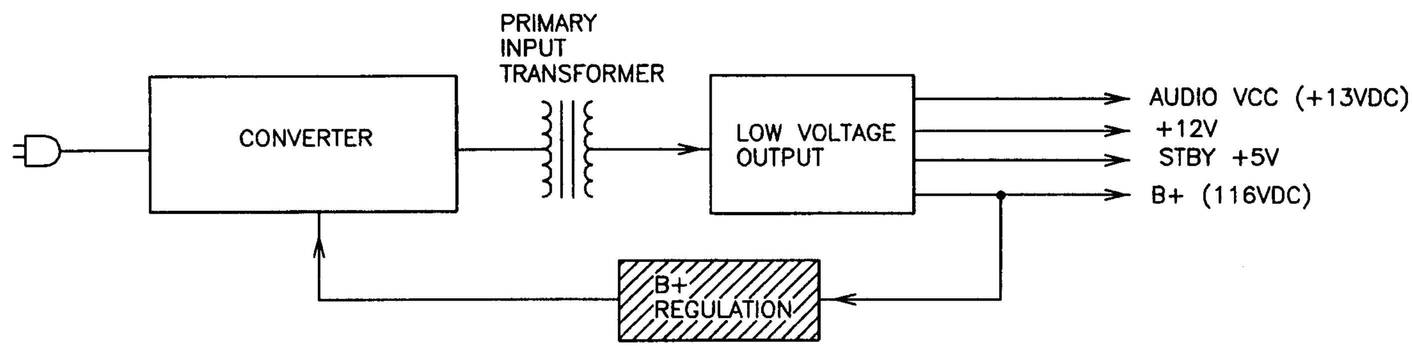
The purpose of this stage is to maintain/regulate the B+ voltage. The input to the power control stage is the B+ voltage. Variations in the B+ voltage will change the converter's oscillator frequency.



Transformer Operation Point

Increasing the oscillator frequency results in a shift along the transformer's resonate frequency curve. This results in a decrease in the transformer's primary to secondary transfer efficiency. Therefore, there is reduced secondary output until the B+ has returned to normal.

Conversely, decreasing the oscillator frequency simultaneously increases the four voltages that leave the voltage output stage. In this power control circuit, the oscillator frequency stops changing when B+ has returned to +116Vdc or 135Vdc (depending upon the set size). This is how the power output control stage regulates the four voltages that leave the power supply.



POWER SUPPLY BLOCK – 20" AND SMALLER

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Converter

In the past, the word "converter" referred to a rotating machine consisting of an electric motor driving an electric generator. This system was used to change alternating current into direct current. Changing AC to DC is also the purpose of this converter, but it is done in an electronic manner.

The converter consists of two parts:

1. The Rectifier
2. The Oscillator

Rectifier

The rectifier changes the 120Volts AC into DC using bridge rectifier D601. The output of D601 is a pulsating DC waveform commonly called the ripple. The 60 Hz ripple has a crest (high point) and a trough (low point). C607 is the main filter capacitor that reduces the ripple amplitude by charging during a crest and discharging to fill a void during the trough. However, as the TV's current demand increases, C607 cannot supply the additional current to the TV during the trough. This is why there is a higher AC ripple across the filter capacitor during a bright scene when there is a greater current demand. This is shown in the chart below:

60 Hz Ripple at Main Filter Capacitor C607	
TV Set OFF	0.8Vp-p across C607
TV Set ON – Dark screen	4Vp-p across C607
TV Set ON – Bright screen	6Vp-p across C607

Oscillator

The oscillator consists of two transistors, a main transformer, a PRT power regulator) transformer (PRT) bias and protection resistors and capacitors. When the oscillator runs, it produces a 180Vp-p square wave into the main Power Input Transformer (PIT) T603/pin 6. The two transistors (IC601) alternately turn ON and OFF to develop the square wave. The operation of the oscillator consists of three parts:

1. A quiescent state
2. When the bottom transistor is ON and the top is OFF
3. When the bottom transistor is OFF and the top is ON

The Quiescent State

The oscillator starts when DC voltage from fusible resistor R606 is applied to the oscillator stage. Two initial current paths are taken toward ground within the oscillator stage. The first current path places both transistors in the IC601 package at the threshold of conduction to establish a quiescent state. This state places 85Vdc at IC601/2's emitter.

First Current Path to Ground		
Component	Input	Output
R606		
R608 & R609	R608	R609
IC601-2	Base	Emitter
IC601-2	Collector	Emitter
R611 & R610	R611	R610
IC602-1	Base	Emitter / Ground
IC602-1	Collector	Emitter / Ground

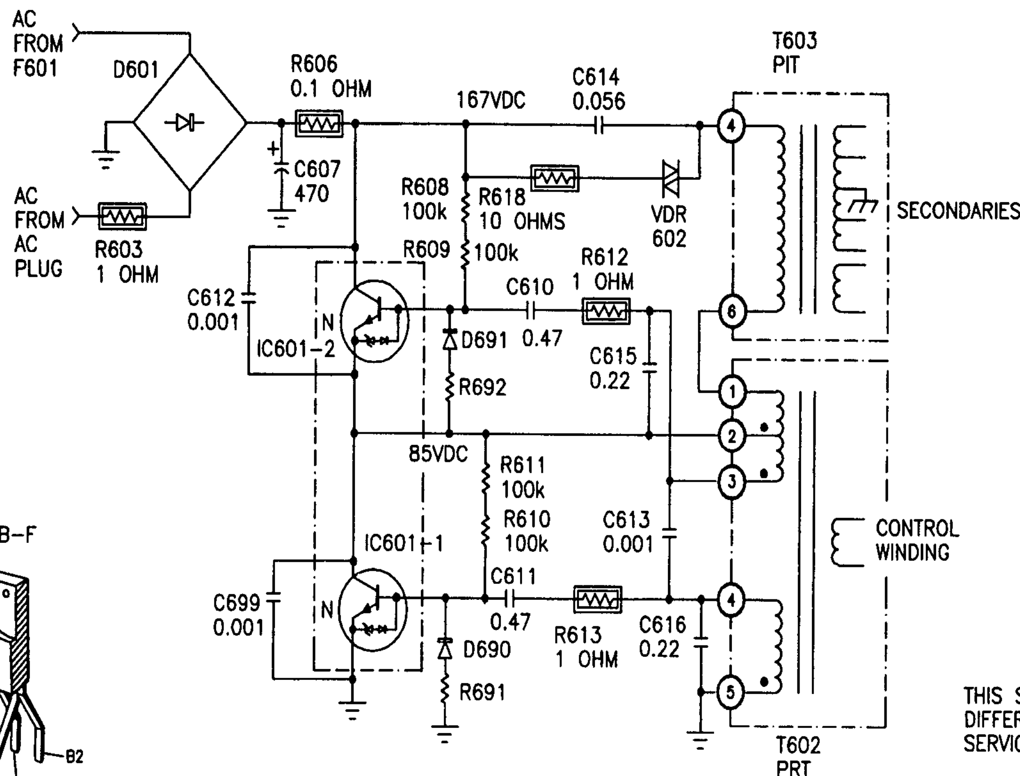
Resistors R608, R609, R611 and R610 form a voltage divider string from the +167Vdc supply to ground. The base – emitter junction of IC601/2 connects resistors R609 and R611. R610 is connected to ground by the base – emitter junction of IC601/1.

The voltage at the junction of R609 and R611 is approximately half the supply voltage because the resistors in the voltage divider string are the same value. Therefore, before oscillation begins, there are 167Volts/2 = 83.5Vdc at IC601/1's collector. At this time, the TV set consumes 40ma AC (C614 removed to stop oscillation).

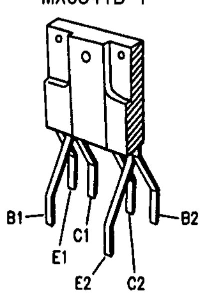
Bottom Transistor IC601-1 Turns ON

The second current path turns OFF transistor IC601-2 and turns ON transistor IC601/1, beginning the oscillator operation. This path passes through several parts to ground:

Second Current Path to Ground		
Component	Input	Output
R606		
C614		
T603 PIT	Pin 4	Pin 6
T602 PRT	Pin 1	Pin 2
R611 & R610	R611	R610
IC601-1	Base	Emitter / Ground
IC601-1	Collector	Emitter / Ground



IC601
MX0541B-F



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A magnetic field is created when current flows through pins 1-2 of PRT transformer T602. This induces a negative voltage that outputs the transformer at T602/pin 3. This negative voltage is applied to the base of IC601-2, turning it OFF.

At the same time, a positive induced voltage from T602/pin 4 is applied to the base of IC601-1. This voltage is held there by capacitor C616 and coupled to the base via C611. The positive voltage drives IC601-1 into saturation (ON). The voltage at the collector of IC601-1 becomes zero by transistor action. This zero volts also appears at T603/pin 6 because the inductance of T602 is small (few windings).

Because C614 initially acts like a momentary short, the full +167 supply voltage is applied to T603's primary transformer windings (pins 4-6). T603's rising magnetic field is coupled into the secondary windings.

Top Transistor IC601-2 Turns ON

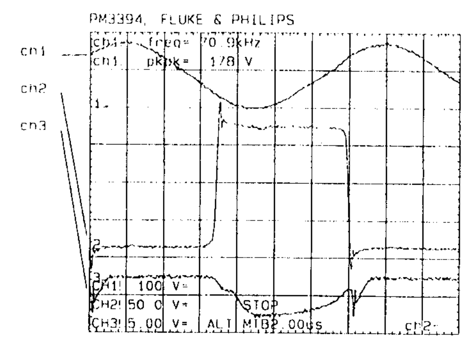
The conduction of the transistors in the IC601 package alternate when the magnetic field in T603 collapses. Eventually, C616's charge leaks off so IC601-1 can no longer be held in conduction. At this time current stops flowing through IC601-1 and PIT T603's primary winding. The magnetic field that is built up in the primary winding of T603 now collapses and current through the primary winding of T603 flows in the opposite direction. During the collapsing magnetic field, current takes this path through IC601-2:

Collapsing Magnetic Field Current Path		
Component	Input	Output
T603/pin 4		
C614		
R608 & R609	R608	R609
IC601-2	base	Emitter
IC601-2	collector	Emitter
T602	pin 2	Pin 1
T603/pin 6		

Both IC601 transistors receive a change in base bias. While current is flowing through T602/pins 2-1, a positive voltage is induced and output T6502/pin 3. This is coupled into the base of IC601-2, turning it ON. At the same time, a negative voltage is induced and output T602/pin 4. This turns IC601-1 OFF. As a result of IC601-2's conduction, its emitter rises to 167Vdc.

When the collapsing magnetic field in T603 has depleted its energy, the cycle repeats, starting with the charging of C614. The result is a square wave at the junction of the two IC601 transistors when they alternately turn ON and OFF.

The following waveform shows the oscillator's square wave output (channel 2) at IC601. It is shown with IC601-1 base bias (channel 3) and the sine wave at the junction of transformer T603 and C614 (channel 1).



Oscillator Stage. TV = ON, 120Vac input.

Channel 1 – T603/pin 4; 50V/div.

Channel 2 – IC601-1 Collector; 50V/div.

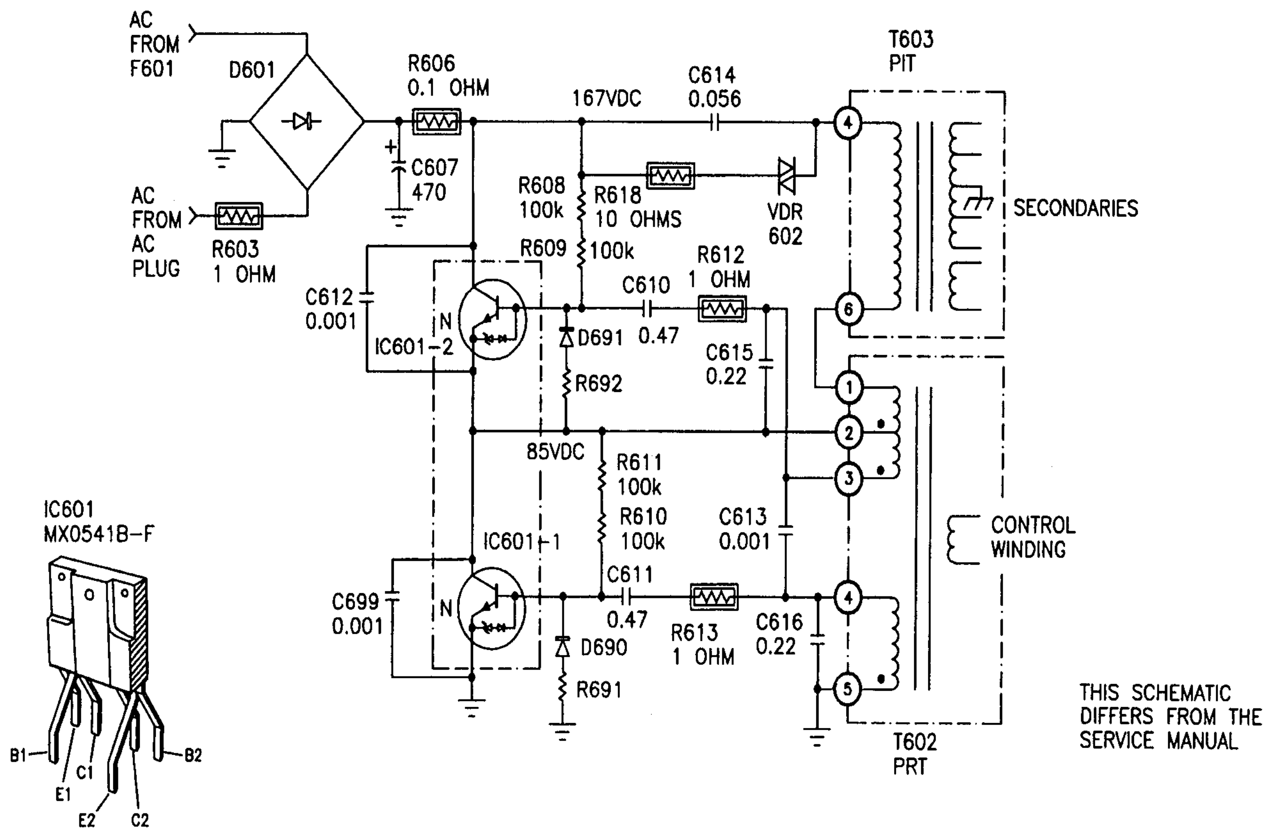
Channel 3 – IC601-1 Base; 5V/div.

Time base = 2usec/div.

Oscillator Stage Protection

Protection 1 – VDR602

All of the TV's power comes through C614 and T603. A bright scene accompanied by a surge in AC line can pass more current through C614 than normal. More current means there would be a greater voltage drop across C614. If the capacitor's maximum voltage is exceeded, it will short and damage the transformer. VDR602 is placed across C614 for its protection. VDR602 is a Voltage Dependant Resistor that only shows low resistance when there is a high voltage across it. When good, it measures like a small capacitor.



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Protection 2 – D690 & D691

The oscillator transistors (IC601) are protected from a base to emitter failure. A transistor's base to emitter junction can be punctured (open) or shorted. By applying an 8-10 volt reverse (b-e) bias voltage from a collapsing magnet field to this junction, the transistor will short. C615, C616 and C613 prevent sharp (high voltage) spikes from leaving the transformer. Diodes D690 and D691 prevent the transistor's base to emitter junction from being reversed.

Protection 3 – C612 & C699

A transistor's collector to emitter junction can be shorted if the maximum voltage across these terminals is exceeded (Vce). Although the typical maximum voltage for these transistors is 600volts, it can still be exceeded when lightning brings in a much higher voltage. The voltage spikes from a non-direct lightning hit may be high in voltage, but low in current (small pulse width). They are bypassed to ground with C612 and C699. If a very high current spike shorted IC601-2 from collector to base, current would also have flowed through C610 and R612 and they should be replaced.

IC601 Protection		
Protection from internal spikes causing immediate failure.	D690/D691 – prevents IC601's E-B junction from reverse bias damage	C615/C616/C613 – rounds off sharp spikes from rising and collapsing magnetic fields.
Protection from external spikes (lightning).	C612/C699 –high voltage low current spikes are circumvented by this capacitor. This reduces the voltage to IC601 so the transistor's C-E breakdown voltage specification is not exceeded.	
Protection - Thermal	R606 (fusible resistor).	

Oscillator Frequency

The oscillator frequency is predominately a function of T602 inductance and capacitors C610, C611, C615 and C616 forming a sine wave at T602/pin2. Since the inductance of T602 is changed with a load, the frequency of the oscillator will be different when the set is turned ON.

Oscillator Characteristics		
Resonate parts:	L = T602 (uH)	C = C610, C611, C615, C616
Frequency:	104kHz. TV OFF (no load)	71.5kHz. TV ON

Oscillator Testing

After replacing parts in this stage, check the following with an ohmmeter before gradually applying power:

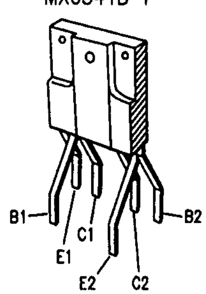
- Shorts in T603 secondary winding loads (secondaries). Check zener diode D610 first (see Converter Voltage Output diagram below)
- Shorts in a flyback secondary winding loads

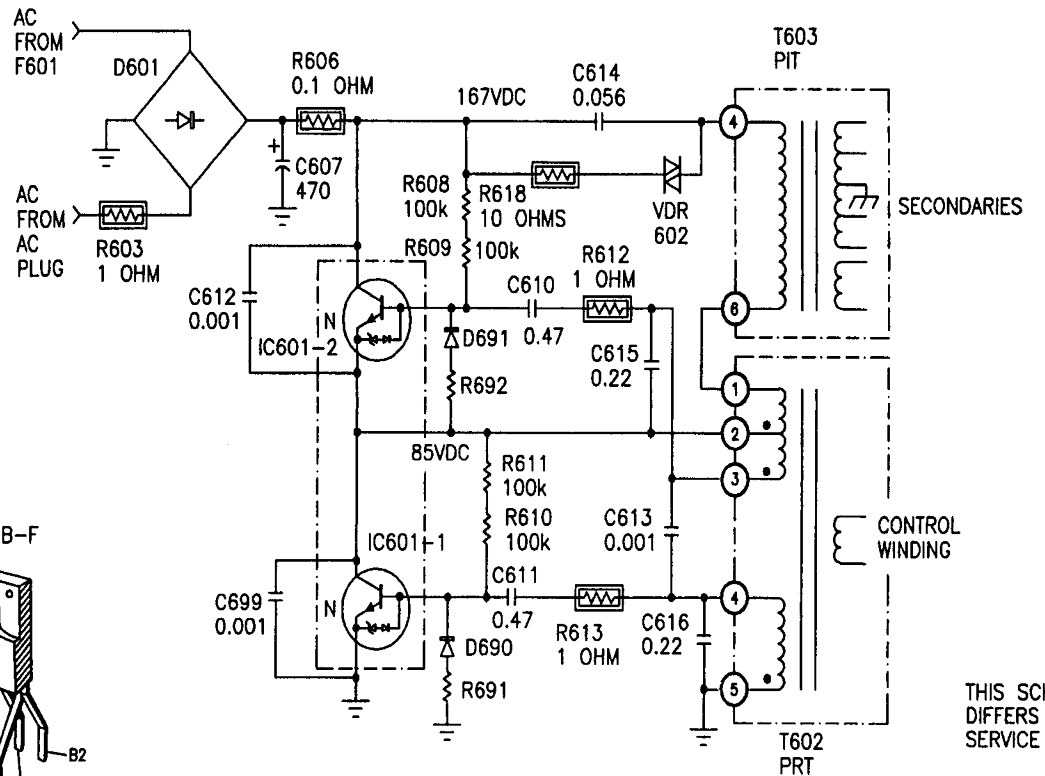
Testing Procedure Steps:

1. Plug the set into an isolated variable AC transformer (must contain an AC ammeter and voltmeter) and set to zero volts AC.
2. Unplug the degaussing coil so the AC ammeter will only show the TV current consumption.
3. Gradually increase the AC voltage to the TV while observing the following:

- The AC current on the variable AC transformer
- The oscillator supply voltage (DC) at fusible resistor R606
- The DC voltage at the collector of the bottom transistor IC601-1

4. Gradually increase the AC voltage. The DC voltage at the collector of IC601-1 will always be half that of the oscillator supply voltage at R606 if the oscillator is OK. This is true at any time, even when the AC voltage is being increased. The oscillator will start when there is about 5-6Vdc at R606.





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What to Expect When Increasing the AC Voltage to the TV	
Observe:	Normal on a 20" BA-4 chassis TV
AC Current (degaussing coil unplugged)	Current will rise to 1 amp at about 12Volts AC, then drop down to 0.34Amps
Oscillator's DC supply voltage at R606	Will increase proportional to the AC voltage being increased.
Collector of IC601-1	Must be half the DC voltage measured at R606. If not, a part is still defective.

Normal Testing Results

Below is a chart that shows the converter/TV operation as AC is increased slowly to the TV that is OFF.

1 Unplug The Degaussing coil during this test.

2 In the 27" BA-4 chassis, the converter can be tested by tempo rarily jumping the TV's ON/OFF relay contacts and removing the load by unsoldering a series inductor L504.

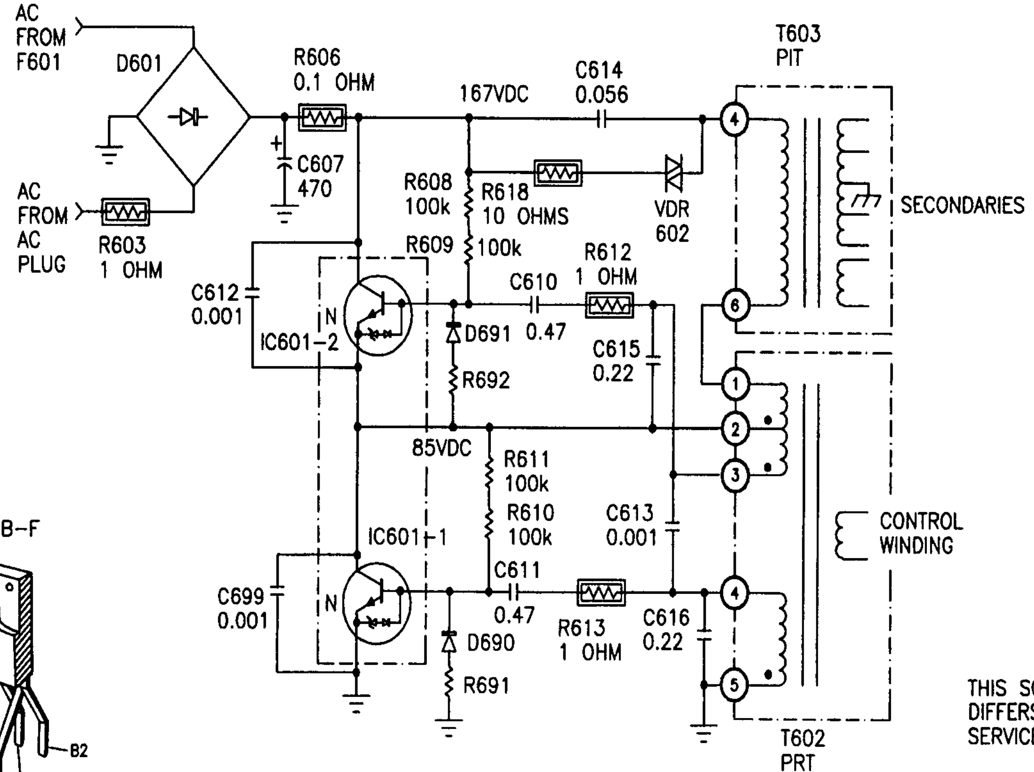
3 Do not disconnect the B+ regulating stage (IC603, DM-58) or the TV will draw an abnormally high current as the AC voltage is in creased.

Increasing Voltages with TV OFF – Sample Model KV20M40				
		Converter IC601-2/E		
AC	DC at R606	Vp-p	Freq.	B+
7 Vac	8 Vdc	20 Vp-p	55kHz	22Vdc
11 Vac	11 Vdc	28 Vp-p (w spikes)	49kHz	108Vdc
22 Vac	25 Vdc	35 Vp-p	51kHz	116Vdc
40 Vac	50 Vdc	60 Vp-p	54kHz	116Vdc
75 Vac	100 Vdc	100 Vp-p	61kHz	116Vdc
110 Vac	150 Vdc	150 Vp-p	78.5kHz	116Vdc
120 Vac	166 Vdc	170 Vp-p	104kHz	116Vdc

4 When beginning to increase the AC voltage to the set under test, the AC current will increase sharply until the B+ reaches the cor rect voltage for that set (116Vdc or 135Vdc) and then drops gradu ally as AC voltage is increased. The degaussing coil is unplugged during this test.

Peak AC Current Consumption		
Model	AC Voltage	AC Current
KV20M40	12Vac	0.8 Amps
KV27S45	11Vac	1.3 Amps

Above 12Vac, the B+ has reached its maximum and the regulation stage changes the converter frequency to supply sufficient TV current to maintain a steady B+ voltage. As the input AC is being increased toward 120Vac, the current continues to drop toward the normal operating level. This TV power supply can run unloaded, but the regulation circuit must remain intact or the unit will damage the converter IC601 and blow a fuse.



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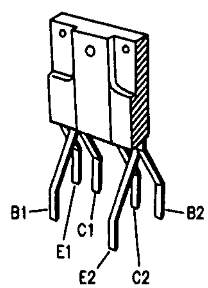
IC601
MX0541B-F



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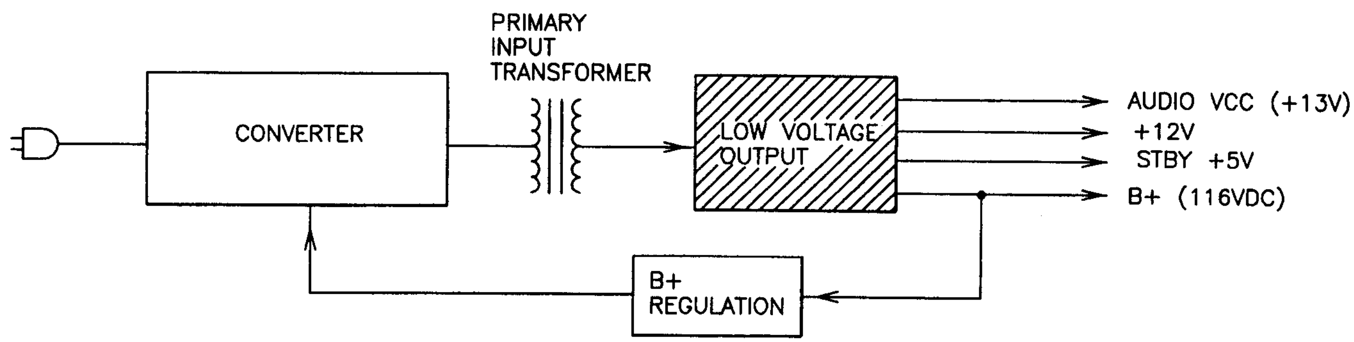

POWER SUPPLY BLOCK – 20" AND SMALLER

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